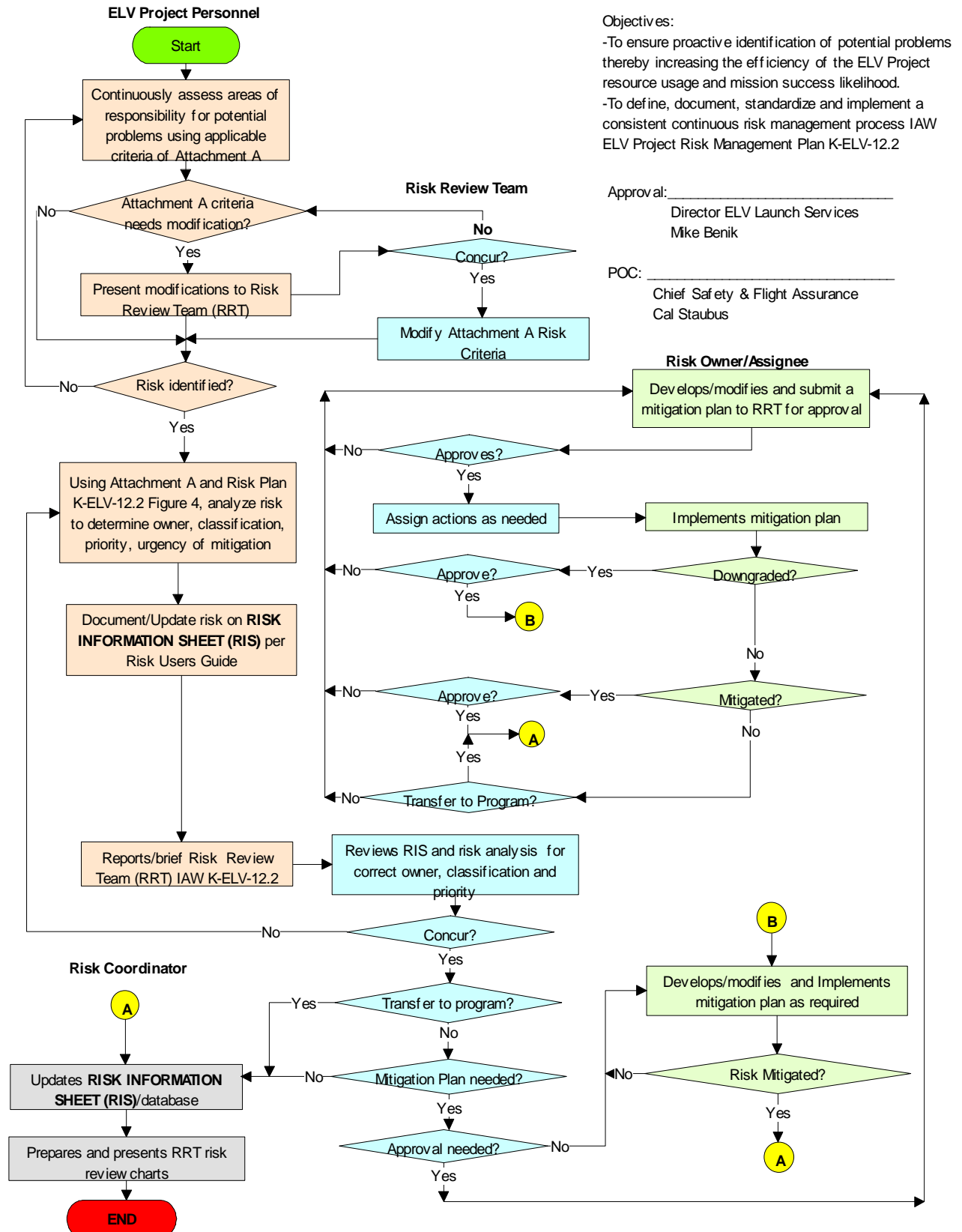


ELV PROJECT CONTINUOUS RISK MANAGEMENT PROCESS



ATTACHMENT A

Technical Risk Criteria

| | | <i>Likelihood Level</i> | | | |
|----------|--|--|---|---|--|
| # | Risk Category | 4 High (91-99%) | 3 Significant (41-90%) | 2 Moderate (10-40%) | 1 Low (1-9%) |
| 1 | Project/Mission | | | | |
| 1 | Key Personnel Experience ELVPO LVC | Expertise not assigned to program | Core expertise only assigned to program | Core expertise assigned and other personnel available and coming up to speed | All required expertise assigned |
| 2 | Processes | Processes are informal | Processes are partially documented and approved | Processes are largely documented and approved | Processes are in place and approved |
| 3 | Analytical Tools | No tool exists for given discipline | Tool identified and in process of procurement, or is under development | Adequate tools in place and being verified with actual data | Adequate tools in use and verified with flight data |
| 2 | Systems Engineering | | | | |
| 1 | Requirements Identification | No defined or detailed process or model to identify requirements | Process established with trial model but not yet proven/implementd | Process established with proven model and being implemented | Process and model well established and requirements identified and approved |
| 2 | Requirements Complexity | Complex requirements interaction based on new design | Complex requirements interaction based on existing design | Typical requirements interaction based on new design | Little or no requirements interaction based on existing design |
| 3 | Requirements Volatility | High requirements change or growth activity | Significant requirements change or growth activity | Changes occurring or likely to occur in some critical requirements | Little or no requirements change activity |
| 4 | Requirements Flowdown and Assumptions | Informal flowdown | Requirements flowdown and documentation less than 50 % at WBS level 3, including suppliers | Requirements flowdown and documentation flowed down to WBS level 3, including suppliers | Requirements flowdown and documentation completed -- including suppliers |
| 5 | Requirements Verifiability | Verification methods do not exist for most requirements | Verification methods do not exist for some critical requirements | Verification methods exist for most requirements | Verification methods exist for all requirements with minor exceptions |
| 6 | Performance Capability | Vehicle cannot deliver payload(s) to acceptable orbit(s) with acceptable margin. | Vehicle can deliver payload(s) to acceptable orbit(s) with reduced but acceptable performance margin. | Vehicle can deliver payload(s) to acceptable orbit(s) with full performance margin. | Vehicle can deliver payload(s) to desired orbit(s) with full performance margin or better. |

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| 7 | Performance Modeling | Vehicle performance model based on immature design (major vehicle systems still under development) and limited heritage; no related configuration has flown. | Vehicle performance model based on mature design with substantial heritage, exact configuration has not flown. | Vehicle performance model is based on 1-5 flights of exact configuration. | Vehicle performance model is based on established flight history (>6) for exact configuration. |
| 8 | Controls Design Process | Design process not defined and may change significantly from mission to mission. Analysis tools are not validated with flight data and may be missing important features. Analyses do not demonstrate controls robustness. | Design process is somewhat defined and small changes may occur mission to mission. Analysis tools have been compared with flight data and generally mimic flight. Analyses do not demonstrate controls design robustness. | Design process is well defined and deviations are rare. Analysis tools are mature and validated with flight experience. Analyses demonstrate controls design robustness. | Design process is well-defined, documented and adhered to. Analysis tools are mature and validated with extensive flight experience. Analyses prove controls design robustness. |
| 9 | Controls Design Margins | One or more requirements not satisfied. Small or negative margins on constraints. | All requirements are met. Some may have very low margins. Constraints may be violated or have little margin. | All requirements are met. All constraints satisfied. Performance relative to objectives is lower than is typical. | All requirements and constraints and most design objectives are met with comfortable margin. |
| 12 | Controls Design Product | Constants generation involves much hand-calculation and/or hand-transcription of data. Little or no checking of as-built vs. as-designed constants. | Constants generation involves some hand calculation and/or hand-transcription of data. Many constants are not checked. | Constants generation is mostly automated. Nearly all constants checked. | Automated constants generation directly from design tools. Thorough checking of as-built vs. as-designed constants. |
| 13 | Communications | TBD | TBD | TBD | TBD |
| 14 | Technology Dependence | Dependent on new technologies that are not yet funded | Dependent on new technologies that are in development | Dependent on innovative use of existing technologies | Minor modification of existing system or COTS |
| 15 | Maturity of Technology | Technology fundamentals understood | New technology with some test bed experience | Technology extensively tested at system level with limited operational or prototype experience | Technology used in existing systems |
| 16 | Systems Test | Test problems identified. | Test problems identified and assessed. | Test problems corrected. | All Operational Analysis problems solved within 25 days. |
| 3 | Environments | | | | |

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| 1 | Thermal | New LV, extensive modifications to LV, or pathfinder thermal control materials or design with no flight or minimal test data, validated by analysis only | New or derivative LV with heritage thermal control systems design, validated with test data and flight performance and data, minimum of 1 to 2 flights | Payload environment and LV thermal control systems performance established and validated by minimum of 3 flights | Payload environment and LV thermal control systems performance well established and understood with minimum heritage of 10 flights |
| 2 | Vibration: Acoustics, sine, random, shock | New or major change to LV, no flight data, analysis only | Derivative LV with some flight data, or new vehicle with 1 or 2 flights | Acoustic database exists for this LV with a minimum of three missions | Acoustic database exists for this LV with a minimum of 10 missions |
| 3 | Coupled Loads Analysis (CLA) Methodology | New LV, major design change to LV, design change for increased performance | Derivative LV, out-of-envelop flight data, LV configuration with 1-5 flights, | S/C out of previous family (mass, cg), LV configuration between 5-10 flights | LV configuration with at least 10 flights, new generic loads analysis theory |
| 4 | Design Loads | New LV, major design change to LV, design change for increased performance | Derivative LV, out-of-envelop flight data, LV configuration with 1-5 flights, | S/C out of previous family (mass, cg), LV configuration between 5-10 flights | LV configuration with at least 10 flights, new generic loads analysis theory |
| 5 | Stress | TBD | TBD | TBD | TBD |
| 6 | EMC/EMI/RF | TBD | TBD | TBD | TBD |
| 4 Hardware | | | | | |
| 1 | Insight Availability | No insight to design processes, meetings, testing, and problem resolution | Insight into design processes, meetings, but not to testing and problem resolution | Insight into design processes, meetings, and testing but not to problem resolution | Maximum insight to all processes, meetings, testing, and problem resolution |
| 2 | Complexity of Component Integration | Complex component interfaces based on new design | Complex component interfaces based on existing system | Typical component interfaces based on new design | Typical component interfaces based on existing design or COTS |
| 3 | Hardware Maturity | State-of-the-Art. Some research complete. | Technology available, complex design | Major change feasible | Minor redesign or existing |
| 4 | Hardware Complexity | Innovative, complex design | Complex design based on existing system | Redesign or repackaging of existing system | Minor modification of existing system or COTS |
| 5 | Maturity of Design Concept | New concept requires significant development | Proof of concept has been demonstrated | Similar concept exists on another program; able to meet requirements by analysis | Fully developed design that meets the requirements |
| 6 | Weight Prediction | Estimates based on analysis only | Estimates based on analytical models -- materials are known | Design complete: Estimates based on mix of analysis and known material weights | Actual weight known -- off-the-shelf |
| 7 | Complexity of Manufacturing | New complex process | Modification of complex process | Validated complex process | Modification of validated moderate complexity process and low cost |

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| 8 | Reliability | Fails to meet reliability requirements | Fails to meet significant reliability requirements | Fails to meet minor reliability requirements | Meets or exceeds reliability requirements |
| 9 | Reliability Predictions | Innovative, complex design with no available reliability data | Complex design based on existing system with no validated reliability data | Redesign or repackaging of existing system with known reliability data | Minor modification of existing system with well understood reliability data or COTS |
| 10 | Supportability | Fails to meet known ILS requirements | Fails to meet significant ILS requirements | Fails to meet minor ILS requirements | Meets or exceeds known ILS requirements |
| 11 | Materials Maturity | Materials not completely identified | New material with some test experience | Complex prototype testing completed | Materials used in existing systems |
| 12 | Supplier Selection | Identification of development of subcontractors required | Non-qualified source | Single qualified source | Dual sourced or no subcontracting |
| 13 | Supplier Expertise | Unknown or no relevant experience; will require major prime assistance | Limited relevant experience; will require prime assistance | Relevant experience; may require prime assistance | Fully capable of performing all tasks |
| 14 | Supplier history | Unknown or unacceptable cost, schedule, or technical performance on relevant contracts | Unacceptable cost, schedule, or technical performance on some relevant contracts | Marginal cost, schedule, or technical performance on relevant contracts | Good cost, schedule, and technical performance on relevant contracts |
| 15 | Supplier Proprietary Rights | Supplier owns the sole rights to a critical design, process, or technology | Supplier owns the sole rights to a critical design, process, or technology but will negotiate license | Proprietary rights to a critical design, process, or technology are licensed to the prime or another supplier | Dual suppliers with independent rights to a critical design, process, or technology or No proprietary rights involved |
| 16 | Supplier Surveillance | Supplier performance surveillance performed as needed | Supplier performance surveillance performed on a scheduled basis by a functional group | Supplier performance surveillance performed on a scheduled basis by the program | Supplier performance tracked using the program Technical Performance Measurement (TPM) |
| 5 | Software | | | | |
| 1 | Software Design | Single element program structure. Mission specific requirements require recode. | Low program modularity. Low mission requirements parameterization. | High program modularity. High mission requirements parameterization. | Fully modular program. Mission requirements via parameters only. |
| 2 | Software Test | Integrated testing limited to generic mission class. New integrated test environment supported by analysis only. | Integrated testing of nominal mission profile only. Heritage test environment with extensive modification based on analysis. | Integrated testing of nominal and 3-sigma dispersed mission profiles. Heritage test environment with analysis derived mission specific parameters. | Full integrated testing including backups and dispersions. Heritage test environment anchored to flight data. |

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| 3 | Hardware-Software Interface Complexity | Complex interfaces between software and hardware subsystems based on new design | Complex interfaces between software and hardware subsystems based on existing system | Typical interfaces between software and hardware subsystems based on new design | Typical interfaces between software and hardware subsystems based on existing design |
| 4 | Software Maturity | New code with limited heritage. New parameters including changes supported by analysis only. | Major modifications driven by changes to vehicle systems. Extensive parameter modification supported primarily by analysis. | Reflight of previous mission code allowing modifications driven by flight experience. In family mission specific parameter modification. | Reflight of heritage mission code and parameters. |
| 5 | Software Engineering Environment | New compiler, linker and media production tools. Critical tools are either unknown or new. | Revision to compiler, linker or media production tools. Critical tools require modification. | Heritage compiler, linker and media production tools. Critical tools require mission specific modification. | Heritage compiler, linker, media production, and critical tools. |
| 6 | Software Troubleshooting | Problems open, solutions under investigation, not duplicated. | Problems open, solutions under investigation, successfully duplicated. | Problems open, solutions identified and corrective actions inwork. | Not open problems or corrective actions verified for open problems. |
| 7 | ELV program office insight | No insight. | Insight limited to review of mission unique change items. | Insight includes mission unique and process level. | Extensive insight allows risk identification and mitigation activity. |
| 8 | Mission Profile | New profile. | Mission profile segments fit collective experience. | Mission profile falls in class of flight experience. | Reflight of previous mission. |
| 9 | Integration process maturity | New process. | Major process modification to accommodate mission. | Minor process modification to accommodate mission unique | Established software development process. |
| 10 | Integration schedule | Schedule compression compromises process or extended work delays. | Schedule compression drives process decisions or repeated launch date slips interrupt flow. | Schedule compression within experience. Minor slips in launch date. | Standard lead times. Continuous effort. |
| 11 | Integration tools | New tools for autogeneration of flight critical parameters. | Major modifications driven by rehost, process change, cost reduction... | Minor modifications to accommodate mission unique or flight experience. | Heritage tools. |
| 6 | Launch Site Integration | | | | |
| 1 | Launch site Operations Concept | Systems fail to meet launch site concept of operations major requirements | Fails to meet significant launch site operations requirements | Fails to meet minor launch site operations requirements | Meets or exceeds launch site operations requirements |
| 2 | Support Equipment | Extensive peculiar support equipment required by KSC | Significant peculiar support equipment required by KSC | Some peculiar support equipment required by KSC | No peculiar support equipment required by KSC |
| 3 | Mission support facilities | Major system broke with no near term solution | Major system broke with repair identified and in work | Minor system malfunction with repair identified and in work | Facility fully function to know requirements |

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| 4 | Requirements Identification | No defined or detailed process or model to identify requirements | Process established with trial model but not yet proven/implemented | Process established with proven model and being implemented | Process and model well established and requirements identified and approved |
| 5 | Requirements Complexity | Complex requirements interaction based on new design | Complex requirements interaction based on existing design | Typical requirements interaction based on new design | Little or no requirements interaction based on existing design |
| 6 | Requirements Volatility | High requirements change or growth activity | Significant requirements change or growth activity | Changes occurring or likely to occur in some critical requirements | Little or no requirements change activity |
| 7 | Requirements Flowdown and Assumptions | Informal flowdown | Requirements flowdown and documentation less than 50 % at WBS level 3, including suppliers | Requirements flowdown and documentation flowed down to WBS level 3, including suppliers | Requirements flowdown and documentation completed -- including suppliers |
| 8 | Requirements Verifiability | Verification methods do not exist for most requirements | Verification methods do not exist for some critical requirements | Verification methods exist for most requirements | Verification methods exist for all requirements with minor exceptions |
| 7 | Safety | | | | |
| 1 | Safety design concept | New concepts and/or systems - never tested at system level | New concepts and/or systems - some test bed experience | Concept extensively tested at system level with limited operational or prototype experience | Thoroughly tested on prototypes with operational experience or COTS |
| 2 | System Integrity | Critical system with no fault detection and failure mitigation | Critical system with limited fault detection and failure mitigation | Critical system with fault detection and limited failure mitigation | Comprehensive fault detection and failure mitigation |
| 3 | Hazardous Materials | Unknown or does not comply with laws and/or regulations | Requires significant work to comply with laws and/or regulations | Believed to comply with laws and/or regulations with minor reservations | Documented compliance with laws and/or regulations |

**ATTACHMENT A Continued
Cost Risk Criteria**

| # | Risk Category | <i>Likelihood Level</i> | | | |
|----|--|--|---|---|---|
| | | 4 High (91-99%) | 3 Significant (41-90%) | 2 Moderate (10-40%) | 1 Low (1-9%) |
| 1 | Key Personnel | Expertise not assigned to program | Core expertise only assigned to program | Core expertise assigned with other personnel available but not yet assigned | All required expertise assigned and fully trained |
| 2 | Processes | Processes are informal | Processes are partially documented and approved | Processes are largely documented and approved | Standard processes are in place and approved |
| 3 | Mission/project Budget Prediction | Limited cost data is available | Estimate based primarily on parametrics | Estimate based on mix of parametrics and actuals | Estimate based primarily on actual costs |
| 4 | Maintenance & Support | Government assumes all risks for maintenance and support | Government assumes most risks for maintenance and support | Government assumes some risks for maintenance and support | Contractor assumes all risks for maintenance and support |
| 7 | Supplier Selection | Identification of development contractors required | Non-qualified source identified | Single qualified source | Dual qualified sources |
| 8 | Cost Prediction Maturity | Limited cost data is available | Estimate based primarily on parametrics | Estimate based on mix of parametrics and actuals | Estimate based on actual costs or NTEs |
| 10 | Supplier History | Unknown or unacceptable cost, schedule, or technical performance on relevant contracts | Unacceptable cost, schedule, or technical performance on some relevant contracts | Marginal cost, schedule, or technical performance on relevant contracts | Outstanding cost, schedule, and technical performance on relevant contracts |
| 11 | Supplier Manufacturing | Will not accept small orders | May not accept small orders | Will accept limited number of small orders | Will accept unlimited number of small orders |
| 13 | Supplier Proprietary Rights | Supplier owns the sole rights to a critical design, process, or technology | Supplier owns the sole rights to a critical design, process, or technology but will negotiate license | Proprietary rights to a critical design, process, or technology are licensed to the prime or another supplier | Dual suppliers with independent rights to a critical design, process, or technology or No proprietary rights involved |
| 14 | Supplier Surveillance | Supplier performance surveillance performed as needed | Supplier performance surveillance performed on a scheduled basis by a 3rd party | Supplier performance surveillance performed on a scheduled basis by the program | Suppliers integrated into the program |
| 15 | Funding | Inadequate funding | Dependent on external funding | Marginal funding available with management reserve | Adequate funding available with management reserve |
| 16 | Requirements Flow down and Assumptions | Requirements undefined | Requirements somewhat known and understood | Requirements known & understood; implementation planning not started | Requirements and their implementation known and understood |
| 17 | Requirements Volatility | High requirements change or growth activity | Significant requirements change or growth activity | Changes occurring or likely to occur in some critical requirements | Little or no requirements change activity |

**ATTACHMENT A Continued
Schedule Risk Criteria**

| # | Risk Category | <i>Likelihood Level</i> | | | |
|---|-----------------------------------|--|---|--|---|
| | | 4 High (91-99%) | 3 Significant (41-90%) | 2 Moderate (10-40%) | 1 Low (1-9%) |
| 1 | Schedule Dependency | Dependent upon multiple critical path activities | Dependent upon one critical path activity | Dependent on multiple non-critical path activities | Dependent on one non-critical path activity or No schedule dependency |
| 2 | Contingency Scheduling | Very tight schedule under ideal circumstances | Contingencies will require overtime or freetime | Contingencies have been identified and incorporated into the schedule | Schedule includes more than adequate time for contingencies |
| 3 | Equipment, Data, and Approvals | > 80 % of tasks depend on external equipment, data, or approvals | 60 - 80 % of tasks depend on external equipment, data, or approvals | 10 - 60 % of tasks depend on external equipment, data, or approvals | <10 % of tasks depend on external equipment, data, or approvals |
| 4 | Key Personnel | Expertise not assigned to program | Core expertise only assigned to program | Core expertise assigned with other personnel available but not yet assigned | All required expertise assigned |
| 5 | Facilities and Capital | Capital investment or new facility needed but not approved | Capital investment or new facility needed and approved | Capital investment or facility in place and allocated but not yet available to program | All resources in place |
| 6 | Schedule Maturity | Top level, time-based schedule | Intermediate level, time-based schedule | Intermediate level, event-based schedule with most predecessors and successors defined | Detailed, networked, event-based schedule with most predecessors and successors defined |
| 7 | Program Similarity | Never been done before by this core program team | Only slight similarity to direct previous experience | 50% similarity | Major features identical to a previous program |
| 8 | Program Experience | Never been done before by this core program team | Program experience resides in just a few individuals | Program experience resides in a minority but key program individuals | Program experience resides in majority of individuals |
| 9 | Configuration and Data Management | Configuration and data management processes are informal | Configuration and data management processes are partially documented and approved | Configuration and data management processes are approved and being implemented | Configuration and data management processes are mostly implemented |

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| 11 | Processes | Processes are informal | Processes are partially documented and approved | Processes are largely documented and approved | Processes are in place and approved with documented continuous improvement |
| 12 | Supplier Selection | Identification of development of contractors required | Non-qualified source | Single qualified source | Dual qualified sources |
| 13 | Supplier history | Unknown or unacceptable cost, schedule, or technical performance on relevant contracts | Unacceptable cost, schedule, or technical performance on some relevant contracts | Marginal cost, schedule, or technical performance on relevant contracts | Outstanding cost, schedule, and technical performance on relevant contracts |
| 14 | Supplier Manufacturing | Will not accept small orders | May not accept small orders | Will accept limited number of small orders | Will accept unlimited number of small orders |
| 15 | Supplier Proprietary Rights | Supplier owns the sole rights to a critical design, process, or technology | Supplier owns the sole rights to a critical design, process, or technology but will negotiate license | Proprietary rights to a critical design, process, or technology are licensed to the prime or another supplier | Dual suppliers with independent rights to a critical design, process, or technology or No proprietary rights involved |
| 16 | Supplier Surveillance | Supplier performance surveillance performed as needed | Supplier performance surveillance performed on a scheduled basis by a third party | Supplier performance surveillance performed on a scheduled basis by the program | Suppliers integrated into the program Integrated Product Teams and TPM |
| 17 | Requirements Flowdown and Assumptions | Requirements undefined | Requirements somewhat known and understood | Requirements known & understood; implementation planning not started | Requirements and their implementation known and understood |
| 18 | Requirements Volatility | High requirements change or growth activity | Significant requirements change or growth activity | Changes occurring or likely to occur in some critical requirements | Little or no requirements change activity |
| 19 | Schedule Deconfliction | LSP and spacecraft schedules have not been reviewed together | LSP and spacecraft schedules have been reviewed together with major conflicts identified | LSP and spacecraft schedules have been reviewed together with minor conflicts identified | LSP and spacecraft schedules have been reviewed together with no conflicts identified |